

APPLICANT: Matthias Brunner et al

SERIAL NO: Not Yet Assigned ART UNIT: 2881  
(Continuation of Serial No. 09/204,430)

FILED: Herewith

FOR: METHOD AND APPARATUS FOR TESTING A SUBSTRATE

EXAMINER: Bruce C. Anderson

Commissioner for Patents  
BOX PATENT APPLICATION  
Washington, D.C. 20231

October 15, 2001

S i r:

PRELIMINARY AMENDMENT

Prior to the examination of the above identified  
continuation application, please amend it as follows:

Substitute the attached one page abstract for the  
abstract originally filed.

Page 1, before line 1, insert the following paragraph:

-- This application is a continuation of application  
Serial No. 09/204,430, filed December 3, 1998, now abandoned. --

Replace the paragraph beginning at page 1, line 1 as  
follows:

-- The invention relates to a method and to apparatus  
for testing a substrate in which a particle beam is directed  
onto the substrate and emitted secondary particles are detected  
with a detector and then evaluated.

BACKGROUND OF THE INVENTION --

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CERTIFICATION 37 C.F.R. 1.10

I hereby certify that, on the date shown below, this correspondence is being deposited with the United States Postal Service, in an envelope as "Express Mail Post Office to Addressee" Mailing Label No. EL025775713US addressed to the Commissioner for Patents, Washington, D.C. 20231.

Date: October 15, 2001

  
Signature

Nicole R. Schmoltz  
(type or print name of person certifying)

Replace the paragraph beginning at page 3, line 10 as follows:

-- The object of the invention is to provide a method and apparatus for improving the testing of substrates having a large surface area.

SUMMARY OF THE INVENTION --

Replace the paragraph beginning at page 3, line 14 as follows:

-- With ever-increasing deflection angles the detector signal also changes in so far as the location of the secondary particles emitted on the substrate relative to the position of the detector has an increasing influence on the number of secondary particles reaching the detector. In other words, the detector signal varies to a large extent with the location of the emitted secondary particles relative to the position of the detector. --

Replace the paragraph bridging pages 3 and 4, beginning at line 20 of page 3 as follows:

-- In order to achieve a uniform signal evaluation over the entire area, therefore, the location of the secondary particles emitted on the substrate relative to the position of the detector is taken into account during testing. In this case there are in principle two variants:

1. Means are provided which guide the secondary electrons from a location or site on the substrate to the detector and are controlled in such a way that a detector signal which is independent of the location is set at the detector.

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2. The location or site of the emitted secondary electrons is not taken into account until the evaluation, i.e. in a comparison with the desired reference signal, in which case either the detector signals are compared with location-dependent desired signals or the detector signals are corrected as a function of the location and then compared with a desired signal. --

Page 4, cancel the paragraph beginning at line 11 and ending on line 13 in its entirety and replace with the following:

-- THE DRAWING

The single drawing figure is a schematic diagram of apparatus for performing the testing method according to the invention. --

Replace the paragraph beginning at page 4, line 14 as follows:

-- THE PREFERRED EMBODIMENT

The apparatus shown in the drawing consists essentially of a particle beam source 1, particularly an electron beam source for producing a particle beam which traverses a path designated by the arrow 2, an optical system 3 for focusing the particle beam, a deflecting arrangement 4 and a detector 5. --

Replace the paragraph beginning at page 5, line 1 as follows:

-- The particle beam is directed onto a selected site of a substrate 8 to be examined, secondary particles being

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emitted along a second path shown by the arrow 9, at least some of the emitted secondary particles being detected by the detector 5. In the detector 5 the detected secondary particles are converted into an electrical detector signal 10 which is supplied to an arrangement 11 for evaluation of the detector signal where the detector signal 10 is compared with a desired or reference signal. --

Replace the paragraph beginning at page 5, line 7 as follows:

-- In order to improve the testing process it is provided according to the invention that the location or site of the secondary particles emitted on the substrate 8 relative to the position of the detector 5 is taken into account during testing. In this case two variants are conceivable in principle which can be used separately or can also be advantageously combined with one another. --

Replace the paragraph bridging pages 5 and 6, beginning at line 16 of page 5 as follows:

-- The underlying idea of this method is that in the case of two different locations  $x_1$  and  $x_2$  on the substrate 8 different detector signals are produced if the other conditions, i.e. in particular the number of emitted secondary particles, are identical. This is based on the fact that the emitted particles are emitted in different directions on the substrate 8 and it is therefore necessary to guide the secondary electrons to the detector. For this extraction electrodes are provided which lead to satisfactory results for small scan areas of a few

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square centimetres. With large deflections, however, markedly different detector signals can occur, although the object examined on the substrate functions in a completely identifiable manner and only its position on the substrate leads to a reduced value detector signal which possibly no longer reaches the necessary desired value. --

Replace the paragraph beginning at page 6, line 12 as follows:

-- The apparatus illustrated in the drawing therefore has a control arrangement 13 which is connected to the deflecting arrangement 4 and the means 12 for guiding the secondary particles. In this way a synchronised control of the means 12 for guiding the secondary particles is ensured as a function of the location or site to which the particle beam is directed. --

Replace the paragraph beginning at page 7, line 1 as follows:

-- The second variant according to the invention is based upon the fact that the dependence of the detector signal upon the location of the emitted secondary particles is not taken into consideration until the evaluation of the detector signal. Thus it would be conceivable that the detector signals determined in each case are compared with respective location-dependent desired or reference signals. As an alternative to this, the location-dependent detector signal could first of all be corrected to a location-independent detector signal in order then to be compared with a desired or reference signal. --

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Replace the paragraph beginning at page 8, line 1 as follows:

-- As the size of the substrate to be tested increases, scanning solely by beam deflection, even with the above-mentioned corrections and provisions for the secondary electron detection, can no longer be carried out. However, a combination of beam deflection with a mechanical displacement of the substrate then allows a test. The substrate 8 is retained for this purpose on a support table 14 which is displaceable at least in a plane perpendicular to the particle beam. The properties of the secondary particle detection can be optimised if the deflection of the particle beam takes place preferably in one direction, whilst the substrate is displaced mechanically in the direction perpendicular thereto. --

Cancel claims 1-14.

Add the following claims.

15. A method of testing a substrate comprising:

directing a particle beam onto said substrate in such manner as to cause secondary particles to be emitted from any selected one of a plurality of sites on said substrate;

guiding at least some of the secondary particles from said one selected site to a signal detector spaced from said one selected site;

generating signals in response to the detection of the detected secondary particles, said generated signals having values which vary in response to changes in the space between said detector and different ones of said selected sites; and

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comparing the respective signals produced in response to the detection of said detected secondary particles from each of said selected sites with a selected predetermined reference signal.

16. The method according to claim 15 including deflecting said particle beam from one selected site to another.

17. The method according to claim 15 including relatively moving said substrate and said particle beam from one selected site to another.

18. The method according to claim 17 including moving said substrate relative to said particle beam.

19. The method according to claim 15 including relatively moving said substrate and said detector to vary the space between said selected site and said detector.

20. The method according to claim 15 including deflecting said particle beam relative to said substrate to change from one selected site to another and thereby vary the space between said detector and said another selected site.

21. The method according to claim 15 including guiding said at least some of said emitted secondary particles directly from said one selected site to said detector.

22. The method according to claim 21 including controlling the guiding of secondary particles to said detector as a function of the space between said detector and the site of the emitted secondary particles.

23. The method according to claim 21 including controlling the guiding of the secondary particles to said detector as a

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function independent of the space between said detector and the site of the emitted secondary particles.

24. The method according to claim 17 including moving said substrate simultaneously and in synchronization with the deflection of said particle beam.

25. The method according to claim 15 including determining the selected predetermined reference signal by calibration of said detector.

26. Apparatus for testing a substrate comprising:  
means for producing a particle beam;  
means for directing said beam along a first path to a selected one of a plurality of sites on said substrate whereby secondary particles are produced and emitted along a second path by said substrate at said selected one of said sites;  
secondary particle detecting means spaced from said selected one of said sites;  
means for guiding secondary particles from said selected one of said sites to said detector means, said detector means being operable to generate a signal having a value which varies in response to differences in the space between said detector and said selected one of said sites; and  
means for comparing the respective signals produced in response to the detection of said detected secondary particles from each of said selected sites with a selected predetermined reference signal.

27. The apparatus according to claim 26 wherein said guiding means comprises deflecting electrodes.

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28. The apparatus according to claim 26 including means for deflecting said particle beam from said one of said selected sites to another of said selected sites.

29. The apparatus according to claim 26 wherein said substrate is supported on a movable support, and including means for conjointly moving said support and the substrate supported thereby.

30. The apparatus according to claim 29 including means for deflecting said particle beam simultaneously with the conjoint movement of said support and said substrate.

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REMARKS

Entry of the foregoing amendments and claims prior to the examination of this application is respectfully requested. The amendments present terminology used in the claims and the claims recite the method and apparatus more in accordance with conventional U.S. practice. No new matter has been added. Every amendment and all claim limitations are clearly set forth in the original disclosure and claims.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attachment is captioned VERSION WITH MARKINGS TO SHOW CHANGES MADE.

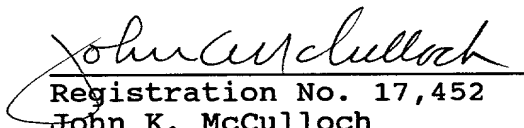
It is believed that this application now is in condition for examination and allowance. Further and favorable action is requested.

The Office is authorized to charge or refund any fee deficiency or excess to Deposit Account No. 12-0755.

Respectfully submitted,

Matthias Brunner et al

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enc

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

Substitute the attached one page abstract for the abstract originally filed.

Page 1, before line 1, insert the following paragraph:

-- This application is a continuation of application Serial No. 09/204,430, filed December 3, 1998, now abandoned. --

The paragraph beginning at line 1 of page 1 has been amended as follows:

-- The invention relates to a method and to apparatus for testing a substrate[, ] in which a particle beam is directed onto the substrate and emitted secondary particles are detected with a detector and then evaluated.

BACKGROUND OF THE INVENTION --

The paragraph beginning at line 10 of page 3 has been amended as follows:

-- The object of the invention is to provide a method and apparatus [according to the preambles to Claims 1, 11 and 13 by which] for improving the testing of substrates having a large surface area [is further improved]. [According to the invention this object is achieved by the characterising features of claims 1, 11 and 13.]

SUMMARY OF THE INVENTION --

The paragraph beginning at line 14 of page 3 has been amended as follows:

-- With ever-increasing deflection angles the detector signal also changes in so far as the location of the secondary particles emitted on the substrate relative to the position of

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the detector [detection] has an increasing influence on the number of secondary particles reaching the detector. In other words, the detector signal varies to a large extent with the location of the emitted secondary particles relative to the position of the detector. --

The paragraph beginning at line 20 of page 3 and ending at 10 of page 4 has been amended as follows:

-- In order to achieve a uniform signal evaluation over the entire area, therefore, the location of the secondary particles emitted on the substrate relative to the position of the detector is taken into account during testing. In this case there are in principle two variants:

1. Means are provided which guide the secondary electrons from a location or site on the substrate to the detector and are controlled in such a way that a detector signal which is independent of the location is set at the detector.

2. The location or site of the emitted secondary electrons is not taken into account until the evaluation, i.e. in a comparison with the desired reference signal, in which case either the detector signals are compared with location-dependent desired signals or the detector signals are corrected as a function of the location and then compared with a desired signal. --

The paragraph beginning at line 11 of page 4 has been cancelled in its entirety and replaced with the following:

-- THE DRAWING

The single drawing figure is a schematic diagram of

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apparatus for performing the testing method according to the invention. --

The paragraph beginning at line 14 of page 4 has been amended as follows:

-- THE PREFERRED EMBODIMENT

The apparatus shown in the drawing consists essentially of a particle beam source 1, particularly an electron beam source for producing a particle beam which traverses a path designated by the arrow 2, an optical system 3 for focusing the particle beam, a deflecting arrangement 4 and a detector 5. --

The paragraph beginning at line 1 of page 5 has been amended as follows:

-- The particle beam [2] is directed onto a selected site of a substrate 8 to be examined, secondary particles [9] being emitted along a second path shown by the arrow 9, at least some of the emitted secondary particles being [of which at least are] detected by the detector 5. In the detector 5 the detected secondary particles [9] are converted into an electrical detector signal 10 which is supplied to an arrangement 11 for evaluation of the detector signal where the detector signal 10 is compared with a desired or reference signal. --

The paragraph beginning at line 7 of page 5 has been amended as follows:

-- In order to improve the testing process it is provided according to the invention that the location or site of the secondary particles [9] emitted on the substrate 8 relative

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to the position of the detector 5 is taken into account during testing. In this case two variants are conceivable in principle which can be used separately or can also be advantageously combined with one another. --

The paragraph beginning at line 16 of page 5 and ending at line 4 of page 6 has been amended as follows:

-- The underlying idea of this method is that in the case of two different locations  $x_1$  and  $x_2$  on the substrate 8 different detector signals are produced if the other conditions, i.e. in particular the number of emitted secondary particles, are identical. This is based on the fact that the emitted particles are emitted in different directions on the substrate 8 and it is therefore necessary to guide the secondary electrons to the detector. For this extraction electrodes are provided which lead to satisfactory results for small scan areas of a few square centimetres. With large deflections, however, markedly different detector signals can occur, although the object examined on the substrate functions in a completely identifiable manner and only its position on the substrate leads to a reduced value detector signal which possibly no longer reaches the necessary desired value. --

The paragraph beginning at line 12 of page 6 has been amended as follows:

-- The apparatus illustrated in the drawing therefore has a control arrangement 13 which is connected to the deflecting arrangement 4 and the means 12 for guiding the secondary particles. In this way a synchronised control of the

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means 12 for guiding the secondary particles is ensured as a function of the location or site to which the particle beam is directed. --

The paragraph beginning at line 1 of page 7 has been amended as follows:

-- The second variant according to the invention is based upon the fact that the dependence of the detector signal upon the location of the emitted secondary particles is not taken into consideration until the evaluation of the detector signal. Thus it would be conceivable that the detector signals determined in each case are compared with respective location-dependent desired or reference signals. As an alternative to this, the location-dependent detector signal could first of all be corrected to a location-independent signal in order then to be compared with a desired or reference signal. --

The paragraph beginning at line 1 of page 8 has been amended as follows:

-- As the size of the substrate to be tested increases, scanning solely by beam deflection, even with the above-mentioned corrections and provisions for the secondary electron detection, can no longer be carried out. However, a combination of beam deflection with a mechanical displacement of the substrate then allows a test. The substrate 8 is retained for this purpose on a support table 14 which is displaceable at least in a plane perpendicular to the particle beam. The properties of the secondary particle detection can be optimised if the deflection of the particle beam takes place preferably in

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one direction, whilst the substrate is displaced mechanically in the direction perpendicular thereto. --

Cancel claims 1-14.

Add claims 15-30.

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ABSTRACT

A method and apparatus for testing a substrate wherein a particle beam is directed onto the substrate and emitted secondary particles are detected by a detector and then evaluated. The location of the site at which the secondary particles are emitted on the substrate relative to the position of the detector is taken into consideration during testing.

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